2506/102
2507/102
AIRCRAFT ELECTRICAL
TECHNOLOGY
Oct./Nov. 2023
Time: 3 hours

THE KENYA NATIONAL EXAMINATIONS COUNCIL

DIPLOMA IN AERONAUTICAL ENGINEERING
(AIRFRAMES AND ENGINES OPTION)
(AVIONICS OPTION)

MODULE I

AIRCRAFT ELECTRICAL TECHNOLOGY

3 hours

INSTRUCTIONS TO CANDIDATES

You should have the following for this examination:
    Answer booklet;
    Non programmable scientific calculator;
    Drawing instruments.
*This paper consists of **EIGHT** questions in **TWO** sections; A and B.*
*Answer **THREE** questions from section A and **TWO** questions from section B in the answer booklet provided.*
All questions carry equal marks.
Maximum marks for each part of a question are as indicated.
Candidates should answer the questions in English.
    Take permittivity of free space: $\varepsilon_0 = 8.854 \times 10^{-12}$ *F/m;*
    Permeability of free space: $\mu_0 = 4\pi \times 10^{-7}$ *H/m.*

This paper consists of 7 printed pages.

Candidates should check the question paper to ascertain that all
the pages are printed as indicated and that no questions are missing.

     Turn over

SECTION A: AIRCRAFT ELECTRICAL INSTALLATION TECHNOLOGY

*Answer **THREE** questions from this section.*

1. (a)   State **two** effects of each of the following on aircraft:

    (i)   lightning strike;
    (ii)   Thunder storms.   (4 marks)

    (b)   Table 1 shows personal protective equipment (PPE) used in aircraft electrical
           installation and their functions. Complete the table.   (4 marks)
           Table 1

PPE	Function
Gloves	-
-	Protects from falling objects
Goggles	-
-	Prevents electrical shock from ground to body.

    (c)   With aid of a labelled block diagram, describe the operation of an aircraft constant
           speed integrated drive generator (IDG) system.   (8 marks)

    (d)   Draw the symbols of each of the following aircraft electrical components:

    (i)   Antenna;
    (ii)   Fuse.   (4 marks)

2. (a)   (i)   State **three** advantages of soldering over brazing.
           (ii)   Explain TNC coaxial cable connector.   (6 marks)

    (b)   With aid of a diagram, describe the process of making a Britannia joint.

                                                                     (7 marks)

    (c)   With aid of a labelled diagram, describe the termination process of a cable
           using eyelet terminal.   (7 marks)

3. (a)   State **three** merits of using aluminium cables in aircraft electrical wiring.   (3 marks)

    (b)   (i)   Define each of the following with respect to fuses:
                   I.   fusing element;
                   II.   fusing factor.
           (ii)   A fuse has a current rating of 20A and a fusing factor of 1.75.
                   Determine the rated fusing current.

                                                                     (4 marks)

(c) With aid of a labelled diagram, describe the principle of operation of differential current protection in aircraft electrical systems. (7 marks)

(d) State **three**:

  (i) indicators found on an aircraft's control panel;
  (ii) merits of sulfur hexa flouride gas circuit breaker. (6 marks)

4. (a) With aid of labelled diagrams, describe each of the following structured cabling topologies used in aircraft:

  (i) Star;
  (ii) Bus. (8 marks)

(b) With aid of a labelled diagram, explain the constructional features of unshielded twisted pair cable. (6 marks)

(c) A fiber optic cable has a core refractive index of 1.55 and a cladding refractive index of 1.5. Determine the:

  (i) relative refractive index;
  (ii) numerical aperture;
  (iii) acceptance angle. (6 marks)

5. (a) (i) Distinguish between luminous flux and luminous intensity with respect to illumination.
  (ii) State the inverse square law of illumination. (4 marks)

(b) An aircraft service area measuring 30m by 20m is illuminated by 40 lamps. The total illumination from the lamps is 250 lux. The efficiency of each lamp is 12 lumens/watt. The utilization and maintenance factors are 0.4 and 0.85 respectively. Determine the:

  (i) total luminous flux;
  (ii) Total lamp wattage;
  (iii) Wattage of each lamp;
  (iv) Depreciation factor

  (8 marks)

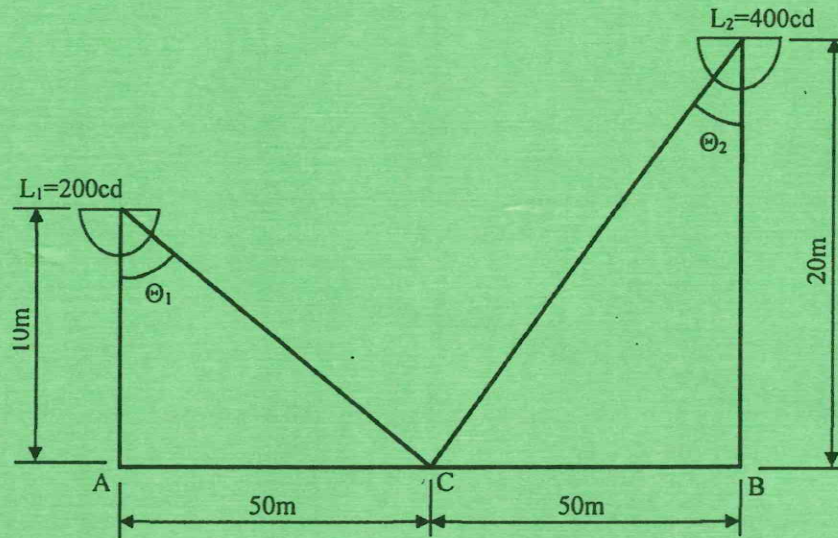(c)   Figure 1 shows an arrangement of two lamps illuminating an aircraft's cabin.

Fig. 1

At point C, determine the:

(i)   Illumination due to lamp L_1;
(ii)   Illumination due to lamp L_2
(iii)   Total illumination.

(8 marks)

SECTION B: ELECTRICAL ENGINEERING PRINCIPLES

*Answer **TWO** questions from this section.*

6.   (a)   Table 2 shows electrical quantities and their units. Complete the table.

(4 marks)

Table 2

Quantity	Unit
Inductance	_
_	Coulomb
Capacitance	_
-	Siemens

(b) A battery consists of ten cells in series each having 1.5 V and internal resistance of $0.2\,\Omega$. The battery supplies a $50\,\Omega$ load. Determine the:

    (i)   total emf;
    (ii)   total resistance in the circuit;
    (iii)   current flowing in the circuit;
    (iv)   potential difference at the battery terminals.   (8 marks)

(c) Figure 2 shows a resistive network. Using superposition theorem, determine the current through the $18\,\Omega$ resistor.   (8 marks)
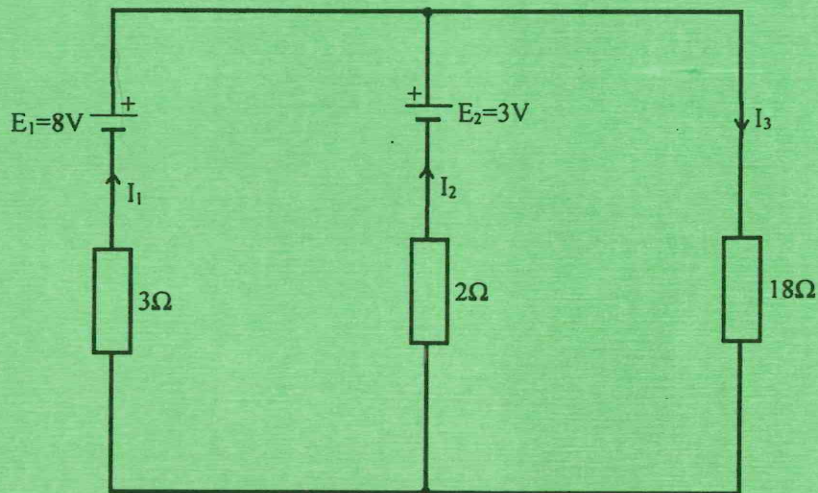

Fig. 2

7. (a) Define each of the following with respect to hysteresis loop:

    (i)   coercive force;
    (ii)   remanence.

        (2 marks)

(b)   Figure 3 shows a steel core magnetic circuit.   Section A is 6cm long and
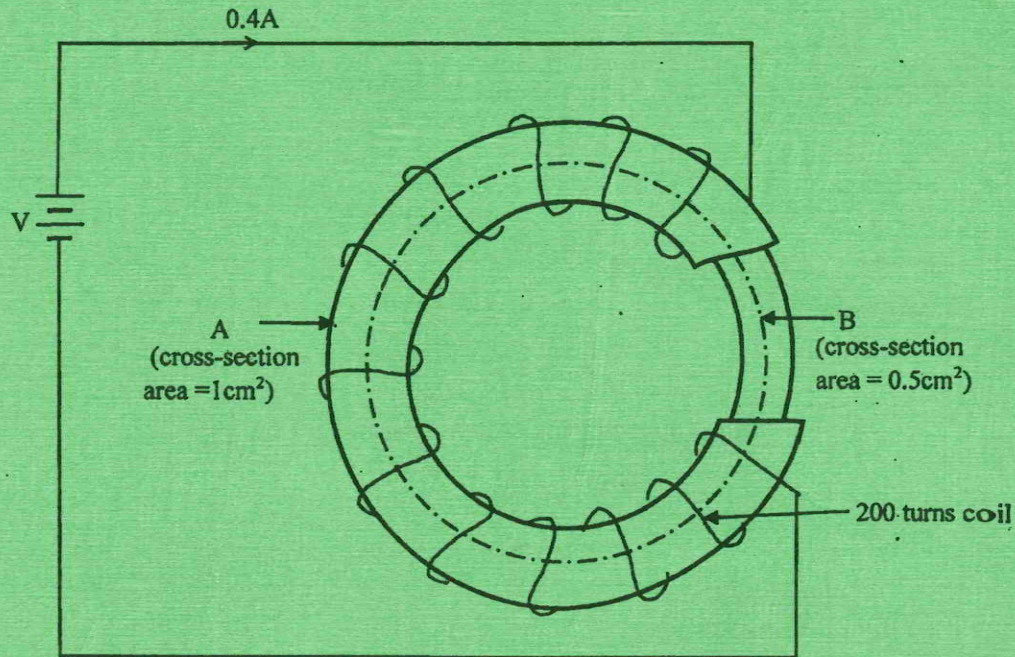   section B is 2cm long. The relative permeability of steel is 750.

Fig. 3

Determine the:

(i)   reluctance of the 6cm long section;
(ii)   reluctance of the 2cm long section;
(iii)   total circuit reluctance;
(v)   Flux in the circuit;
(v)   Flux density in the 2cm long section.   (10 marks)

(c)   A ceramic capacitor has a capacitance of $0.01\,\mu F$ and a working potential of 2.5kV.
        The field stress of the capacitor is 10 MV/m and the relative permittivity of the
        ceramic is 10.
        Determine the:
(i)   Thickness of the ceramic dielectric;
(ii)   area of the plates;
(iii)   charge stored by the capacitor;
(iv)   energy stored by the capacitor.   (8 marks)

8. (a) Define each of the following with respect to a.c circuits:

   (i) instantaneous value;
   (ii) Q-factor. (2 marks)

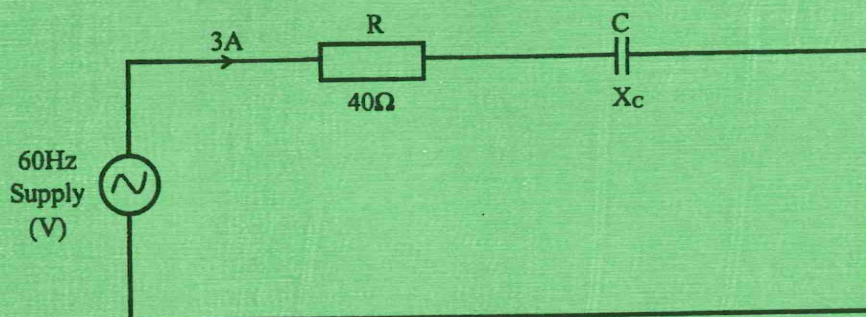   (b) Figure 4 shows an R-C circuit. The total circuit impedance is $50\,\Omega$.

Fig. 4

   Determine the:

   (i) capacitive reactance, Xc;
   (ii) value of capacitor C;
   (iii) supply voltage V;
   (iv) phase angle, ϕ;
   (v) potential difference across the capacitor, Vc. (10 marks)

   (c) A 5 kVA single-phase transformer has a turns ratio of 10:1 and is fed from a 2.5 kV supply. Neglecting losses, determine the:
   (i) secondary voltage;
   (ii) full load secondary current;
   (iii) load resistance;
   (iv) primary current.

   (8 marks)

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